

SECTION 'B' (Short-Answer Questions) (36)

NOTE: Answer any NINE part questions from this section. All questions carry equal marks. Draw diagrams where necessary. Use of scientific calculator is allowed.

2. i) With the help of diagram show the forces acting on a car moving on a banked curve and derive the mathematical expression for banking angle $\theta = \tan^{-1} \frac{v^2}{rg}$

ii) How far apart must two protons be if the magnitude of the electrostatic force acting on either one due to the other is equal to the magnitude of the weight of a proton on earth's surface. ($m = 1.67 \times 10^{-27} \text{ kg}$, $q = 1.6 \times 10^{-18} \text{ C}$)

iii) State Kirchhoff's first and second law. Draw diagram for both the laws.

iv) A mortar shell is fired at a ground level target 500m distance with an initial velocity of 90 ms^{-1} . What is the launch angle?

v) How energy is stored in a capacitor? Derive mathematical expression for the energy stored in capacitor.

vi) Define escape velocity. Derive the relation $v_m = \sqrt{2gR}$ for escape velocity on earth's surface.

vii) The small piston of a hydraulic press has an area of 10 cm^2 . If the applied force is 50N what must the area of the large piston to exert a pressing force of 4800 N.

viii) A block is kept on a horizontal table. The table is undergoing simple harmonic motion of frequency 3Hz in a horizontal plane. The coefficient of static friction between the block and the table is 0.72. Find the maximum amplitude of the table at which the block does not slip on this table.

ix) Derive Bragg's equation for X-ray diffraction.

x) Calculate the viscous drag on a drop of oil of 1mm radius falling through air at its terminal velocity. (viscosity of air = 1.8×10^{-5} poise, density of oil = 850 g/m^3).

xi) A 20 meter long wire has a cross sectional area of 1 mm^2 and having a resistance of 50 ohm . Calculate the conductivity of the wire.

xii) State the law of conservation of linear momentum. By using the law, calculate the speed of recoil of the gun, when a 100g bullet is fired from a 10kg gun with a speed of 1000 m/s .

xiii) Prove that following equations are dimensionally correct.

$$* T = 2\pi \sqrt{\frac{l}{g}} \quad * x = m \frac{\lambda}{2}$$

xiv) Write Newton's formula for the speed of sound in air. What correction did Laplace made in it? Also give the corrected formula.

SECTION 'C' (Detailed Answer Questions) (32)

NOTE: Attempt any TWO questions from this section. All questions carry equal marks. Draw diagrams where necessary.

3. a) What is Bernoulli's principle? Derive Bernoulli's equation for steady, incompressible, non-viscous and irrotational flow of fluid.

b) What is an electric dipole? Derive the expression for electric field intensity due to electric dipole at a point which is at a perpendicular distance y from the centre of the dipole.

4. a) Describe the addition of vectors by Head to Tail method. Add two vectors $\vec{P}$ and $\vec{Q}$ making angles θ_1 and θ_2 with the horizontal by rectangular component method.

b) Name the acceleration due to the change in direction of linear velocity of a body moving in a circle. Derive the relevant expression for it in terms of linear and angular velocities.

5. a) Define simple harmonic motion. Using the expression of instantaneous velocity $v = \frac{K}{m} \sqrt{x_n^2 - x^2}$ of a body executing S.H.M, prove that the total energy of the body is constant.

b) What is Doppler Effect? Derive mathematical expression for apparent frequency heard by listener when:

i) Listener moves towards stationary source

ii) Source moves towards stationary listener